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ABSTRACT

In 1985, Indiana joined the growing list of states assessing students' achievement at various levels. During February 1985, over 63,000 third-grade students took the 40-item Indiana Basic Competency Skills Test. A mean of 34.7 was achieved. An item analysis was performed for a random sample of 6,439 students (approximately 10%). Findings confirm the national assessment results that students generally do very well computing with whole numbers, and no single item was answered correctly by less than 70 percent of the sample. Difficulties with items on geometry and problems involving graphs and charts are discussed. (MNS)

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RESULTS OF THE INDIANA BASIC COMPETENCY SKILLS TEST IN MATHEMATICS: WHAT ARE THE PROBLEM AREAS AND WHY?

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Introduction

In 1985 Indiana joined a growing list of states and U.S. territories that are assessing students' achievement at various grade levels. With the major purpose of the Indiana assessment being to assist educators with the implementation of remedial programs, the State Board of Education focused its efforts on skill areas in which the National Assessment of Educational Progress (NAEP) found students to be lacking: critical thinking, comprehension, mathematics problem solving, and persuasive writing.

Results on the Indiana Basic Competency Skills test for third graders have been returned to local school corporations, and recently, after a legal ruling cleared the way, have been released to the public. With the increased emphasis in the United States on mathematics, there is an urgency to analyze any shortcomings that might be observed in the results so that remedial programs can be established. Thus, the thrust of this article is to identify and discuss these findings in relation to NAEP results from the third mathematics assessment completed in 1982.

NAEP Results

Over 46,000 students participated in the 1982 NAEP mathematics assessment. Sampling procedures were designed to provide representative groups of 9, 13, and 17 year old students with attention to community types and sizes, races, and family backgrounds.

The findings show that 9-year old students:

1. are better at computing with whole numbers than in the second assessment, with a marked improvement in multiplication;
2. are familiar with metric measurement;
3. have made no improvement on solving one-step verbal "story problems," or non-routine problems;
4. cannot perform mental computations well; and
5. have not developed estimation skills.

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Mathematics educators on the NAEP interpretative panel stated, "In general, the results of this assessment indicate that our schools are doing a good job of teaching those mathematics topics that are relatively easy to teach." Their major recommendation for revamping the traditional mathematics curriculum is to focus on higher-level cognitive activity as part of the instructional setting.

Indiana Basic Competency Skills Test in Mathematics

During February 1985, over 63,000 Indiana third grade students took the Indiana Basic Competency Skills Test (IBCST), developed and analyzed by CTB/McGraw-Hill. The 40-item mathematics test was divided into two subtests, with each subskill being measured by five items.

- Computation
  - Addition
  - Subtraction
  - Multiplication
- Concepts and Applications
  - Numbers and Numeration
  - Geometry
  - Measurement
  - Number Sentences
  - Graphs and Charts

The statewide results are reported in Table 1.

Table 1
Results on the IBCST in Mathematics
3rd Grade - 1985

Number of students	63,134
Mean	34.7
Standard Deviation	5.33
Internal Consistency	.87

An item analysis using all test results was not performed, rather an item analysis for a statewide random sample of 6439 students (approximately 10%) was conducted. The discussion which follows is based on the results from this sample. Items correctly answered by less than 80% of the sample are highlighted.

Findings confirm the NAEP results that students generally do very well computing with whole numbers. Two items from the group of 15 computation items, however, require discussion since less than 80% of the sample correctly responded to each.

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8

$80 - 5 =$

- ○ 30
- ○ 75
- ○ 85
- ○ 130
- ○ None of these

15

$$\begin{array}{r} 6 \\ \times\ 7 \\ \hline \end{array}$$

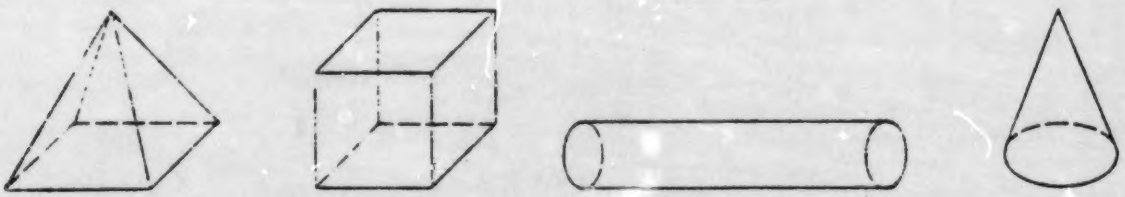
- ○ 42
- ○ 43
- ○ 46
- ○ 67
- ○ None of these

For Item 8, 19% of the sample chose 85 as the answer. Two reasons for this error seem apparent: 1) incorrect reading of the operation as addition; and 2) improper use of the subtraction algorithm involving regrouping and renaming. Only Item 8 tests this skill.

Item 15 was answered correctly by only 70% of the sample, while 15% incorrectly chose "None of these." Since students did well on the first four multiplication items, it is not readily apparent why such a large percent of the sample answered incorrectly. One possible explanation is that this particular basic fact had not been taught prior to the early testing in February, whereas the other multiplication skills had been taught.

Two geometry items were also answered correctly by less than 80% of the sample. The study of three dimensional geometry, tested by Item 21, is often relegated to a backseat position in the elementary mathematics curriculum, with many teachers providing little or no instruction. Fifteen percent of the sample incorrectly chose the "cylinder" as a "pyramid." Why? Could the results for this item be confirming Piaget's stages of development in the study of three-dimensional figures. The student "sees" a triangle in the first illustration, a square in the second, and a triangle or circle in the fourth. Therefore, not knowing what a pyramid looks like, the student chooses the "cylinder" illustration as his response.

21 Which figure is a pyramid?



○ ○ ○ ○

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Although only 78% correctly chose the fourth figure for Item 23, the remainder of the incorrect responses were mixed. No obvious reasons for choosing the alternatives are apparent.

23 Which figure is divided into 2 triangles?

○ ○ ○ ○

○ None of these

As a part of problem solving, methods of gathering, organizing, and interpreting information are areas identified by the National Council of Teachers of Mathematics in its Agenda for Action: Recommendations for School Mathematics in the 1980s for emphasis in the K-12 mathematics curriculum. With two items being answered correctly by less than 80% of the sample, one might question the emphasis being placed on this skill area in Indiana, even though three of the items were answered correctly by more than 80% of the sample. Reading and interpreting graphs is an essential skill for students to learn.

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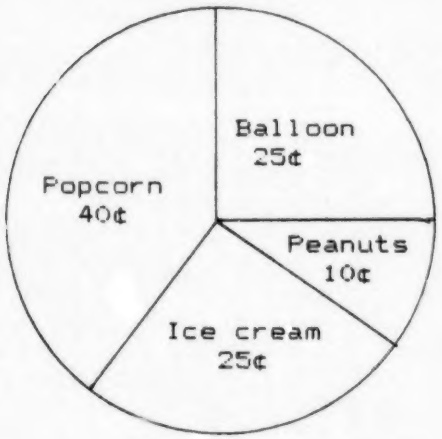
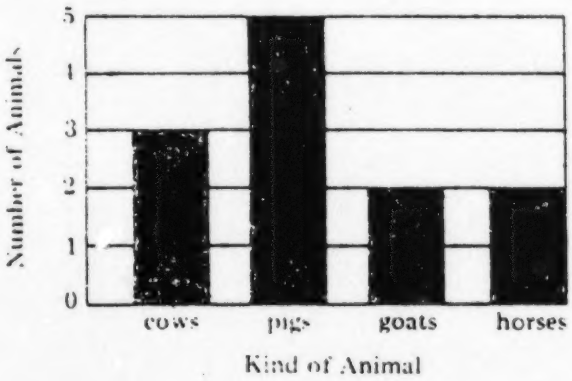
The graph shows how Debby spent $1.00 at the circus. Study the graph. Then do Numbers 38 and 39.

CIRCUS MONEY



The graph shows the number of animals on a farm. Study the graph. Then do Number 40.

ANIMALS ON THE FARM



39 Which of the following cost as much as the balloon?

- ○ popcorn only
- ○ ice cream only
- ○ peanuts and ice cream
- ○ popcorn and ice cream
- ○ None of these

40 What is the total number of animals on the farm?

- ○ 5
- ○ 7
- ○ 10
- ○ 12
- ○ None of these

In Item 39, 13% of the students incorrectly chose "popcorn only." Is this response influenced by the wording of the question, as a result of using the phrase "cost as much as?" Does this phrase imply to students "equal to or more than?" Responses to Item 40 suggest that students do not know how to interpret bar graphs, since 12% incorrectly selected "5" as the answer, the high point on the graph rather than the sum of all the frequencies.

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Recommendations

The facts that the mathematics test mean was 34.7 out of 40, and that no single item was answered correctly by less than 70% of the sample speaks well for the overall assessment of third grade students' mastery of mathematics objectives. Yet, Indiana educators need to be concerned about the apparent lack of skills in the Graphs and Charts subskill area. The National Council of Teachers of Mathematics has recommended that the mathematics curriculum should be organized around problem solving, with basic skills being defined to encompass more than computational facility. Students must be taught mathematical skills to deal with real world problems. Daily and weekly statistical reports, charts and graphs, in newspapers and magazines provide evidence for the need for such skills.

As suggested earlier, students do very well computing with whole numbers. Perhaps then, more items on future tests should be devoted to measuring problem solving skills, including one-step "story problems" and non-routine problems.

With the State Board of Education continuing and extending the testing and remediation program, and with corporations throughout the state adopting new elementary mathematics textbooks during this academic year, hopefully we will see an improvement in the skill areas discussed in this article.

Note: Due to a request from the Indiana Department of Public Instruction, numbers on certain items and answers have been changed.

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